The influence of prosodic prominence on language processing in German

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List of publications

This cumulative dissertation is based on the following peer reviewed publications (the numbering corresponds to the order in which the studies will be discussed in this dissertation):

Peer reviewed:

Study 1a: Zeyer, Barbara & Penke, Martina. 2023. The processing of prosodic prominence in German. In Skarnitzl, Radek & Volín, Jan (eds.), *Proceedings of the 20th International Congress of Phonetic Sciences*. 4071–4075. Prague: Republic: Guarant International.

Study 1b: Zeyer, Barbara & Penke, Martina. 2024b. Prosodic prominence does not speed up word recognition in a word monitoring task with German adult speakers. *Glossa: a journal for general linguistics* 9(1).

Study 2: Zeyer, Barbara & Penke, Martina. 2024a. Prosodic prominence and its hindering effect on word recognition memory in German. *Proceedings of the 12th Speech Prosody*. 1135–1139. Leiden, Netherlands.

1. Introduction

The use of prosody is crucial for successful communicative interaction. The functions of prosody are manifold and broadly discussed in the literature. Amongst others, prosody can signal if an utterance is a statement (often falling intonation) or a question (often rising intonation) and divides an utterance into smaller chunks that make the whole sentence easier to understand (also known as chunking; e.g., Ladd, 2008). Furthermore, prosody helps indicate turn-taking (e.g., Duncan, 1972; Schaffer, 1983; Cutler & Pearson, 1986; Selting, 1996; Gravano & Hirschberg, 2011; Ward, 2019), transport emotion (e.g., Cruttenden, 1986; Johnstone & Scherer, 2000; Bänziger & Scherer, 2005; Mitchell & Ross, 2013; Laukka, 2017), or signal information structure (e.g., Gussenhoven, 1983; Bolinger, 1986; Pierrehumbert & Hirschberg, 1990; Chafe, 1994; Lambrecht, 1994). In order to mark, for instance, a particular information structure, elements are highlighted. This highlighting is called prosodic prominence. Prosodic prominence is defined as the standing out of an entity from its environment (e.g., Terken & Hermes, 2000; Steefkerk, 2002).[1] Although the remainder of this thesis will investigate the effects of prosodic prominence per se, the next paragraph will describe how prosodic prominence can help signal information structure to get a clearer picture why prosody, more specifically prosodic prominence, is important for successful communication and why it is worth to be further investigated.

By marking an entity as *new* or *given* (or *accessible*) or distinguishing between *background* and *focus* (e.g., Gussenhoven, 1983; Bolinger, 1986, Pierrehumbert & Hirschberg, 1990; Chafe, 1994; Lambrecht, 1994), prosody signals information

[1] See Section 2.1 for a more detailed definition of prosodic prominence.

structure. For German, it has been found that *new* referents are most likely marked with a high pitch accent, whereas *given* or *accessible* referents are most likely marked with low pitch accents or are deaccented (e.g., Baumann & Hadelich, 2003; Baumann, 2006; Baumann et al., 2015; Lorenzen et al., 2024). Lorenzen et al. (2024) furthermore found that *accessible* referents tend to be produced prosodically less prominent than *new* referents. This is in line with a study by Baumann et al. (2015), who found that *new* referents are more likely prosodically more prominent than *given* referents. The results of both findings coincide with literature that argues that *new* referents are less (pre-)activated for both the speaker and the listener and need more activation from the side of the speaker, hence the more pronounced prosodic prominence for *new* referents (see e.g., Chafe, 1994; Lambrecht, 1994). Likewise, entities that are in *focus* are often associated with being accented in comparison to information that is in the *background* (e.g., Féry, 1993; Féry & Kügler, 2008).

Independent from the aforementioned linguistic and paralinguistic functions of prosody, accents types in German vary with regard to the degree of how prominent they are perceived (Baumann & Röhr, 2015). In German, prosodic prominence is expressed to different degrees by various accent types (Baumann & Röhr, 2015). For instance, a rising pitch accent makes a word prosodically more prominent than a falling pitch accent.

Prosodic prominence has been subject to a number of (psycho-)linguistic studies. Generally, prosodic prominence appears to facilitate language processing. For instance, speakers are better able to remember words when they are prosodically prominent (e.g., Fraundorf et al., 2010; Savino et al., 2020; Kember et al., 2021; Röhr et al., 2022; Zhou et al., 2024). Participants are also faster in identifying a word in an

utterance when it is prosodically prominent (e.g., Cutler & Swinney, 1987). Finally, when speakers listen to sentences in eye-tracking studies, they look faster to the correct referent when it is prosodically prominent (e.g., Weber et al., 2006; Ito & Speer, 2008).

Previous research has mainly focused on English and has found facilitatory effects of prosodic prominence on language processing, such as faster identification times or a better recognition memory for prosodically prominent target words (e.g., Cutler & Swinney, 1987; Fraundorf et al., 2010). What remains open at this point is whether the facilitatory effects of prosodic prominence observed for English can also be generalized for German. Additionally, it remains an open question whether accent types that differ in their degree of perceptual prominence (Baumann & Röhr, 2015) facilitate language processing to a graded degree. While previous research has focussed on the facilitatory effects of prosodic prominence, it remains, to this point, unclear if prosodic prominence might also impede language processing to an extent. The aim of the following dissertation therefore was to close this research gap and to examine how prosodic prominence influences language processing in German. Therefore, this dissertation puts forward the research question

How does prosodic prominence influence language processing in German?

The dissertation is structured as follows: In Chapter 2, prosodic prominence will be defined before relevant studies will be discussed in more detail. Chapter 3 will introduce and develop the research question. Chapter 4 and Chapter 5 will present results of the conducted studies, respectively. The original studies can be found in the

supplementary material. Chapter 6 will discuss the results of the conducted studies with reference to the research question. Finally, Chapter 7 will conclude the thesis.

2. Background

2.1 Prosodic prominence in German

One of the key functions of prosody is to emphasize certain parts of a word or certain words in an utterance. In intonation languages, this emphasis is realised through pitch accents. Following the autosegmental-metrical theory (AM), pitch accents "may serve as concrete perceptual cues to stress or prominence" and usually consist of high (H) and low (L) tones (Ladd 2008: 44; see also Bolinger, 1958). Pitch accents are associated with the stressed syllable in a word, while edge tones are at the boundaries of larger units (Ladd, 2008).

For English, a framework called Tones and Break Indices (ToBI; Beckmann & Hirschberg, 1994) was introduced. It is a system for phonetic transcriptions of the intonation of a language. This framework was adopted for German, also known as German Tones and Break Indices (GToBI), by Grice et al. (1996; see also Grice et al. 2005). The GToBI inventory describes six pitch accent types and eight edge tones (Grice et al., 2005). As edge tones are not of interest for the present dissertation, they will not be discussed further. The six pitch accent types are shown in Table 1. Pitch accents are either monotonal (H*, L*) or bitonal (L + H*, L* + H, H + L*, H + !H*). High tones (H) are usually in the higher three quarters relative to a speaker's pitch range while low tones (L) are usually produced in the lowest quarter of a speaker's pitch range (Grice et al., 2005). The starred tone, indicated by an asterisk, *, is argued to "phonetically align with the accented syllable" (Grice et al., 2005: 58).

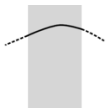
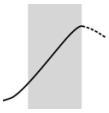
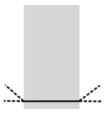
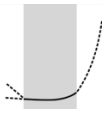
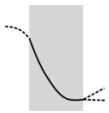
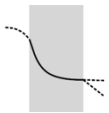
Pitch accent	Description
H* 	'peak accent'; perceived as relatively high, may follow a shallow rise
L + H* 	'rise from low up to peak accent'; accented syllable is perceived as high, follows a low pitch with a steep rise to the accented syllable
L* 	'low accent'; a speaker's local pitch minimum, may follow a shallow fall
L* + H 	'valley accent plus rise'; accented syllable is low; precedes a rise, peak in the next syllable
H + L* 	'step down from high to low accent'; accented syllable at the bottom of speaker's range, follows a high pitch
H + !H* 	'step-down from high to mid accent'; accented syllable follows a higher pitch, accented syllable in the middle of speaker's peak and baseline

Table 1: Description of the six pitch accent types in German, adapted from Grice et al. (2005). The depiction of the pitch accents is taken from the GToBI website (http://www.gtobi.uni-koeln.de/gm_ta_tonakzente.html). The accented syllable is marked in grey.

Through pitch accents, words can be highlighted. This highlighting is referred to as prosodic prominence. Prosodically prominent words are hyperarticulated, that is, they might be louder, longer or produced with a greater pitch excursion compared to the entities in their environment (de Jong, 1995; Ladd, 2008; Himmelmann & Primus, 2015). These properties are described as prominence-lending cues (Himmelmann & Primus, 2015; Baumann & Winter, 2018). By that, prosodically prominent entities stand out from their environment (e.g., Bolinger, 1958; Fry, 1958; Terken & Hermes, 2000; Steefkerk, 2002; Himmelmann & Primus, 2015; von Heusinger & Schumacher, 2019). As such, prosodic prominence is considered to be a relational property (e.g., Himmelmann & Primus, 2015; Cangemi & Baumann, 2020). That means that prosodic prominence is established by not only taking into consideration the highlighted entity itself but also the neighbouring elements (e.g., Himmelmann & Primus, 2015). Himmelmann & Primus (2015: 43) further argue that prosodic prominence is the "relation between elements of the same type", i.e., a word is prosodically prominent compared to another word in the same utterance, a syllable is prosodically prominent compared to other syllables in the same word and so on. In addition to that, prosodic prominence is defined as context-dependent: "it is a central characteristic of prominent units to alternate or shift in accordance with the context" (Himmelmann & Primus, 2015: 44). In a sentence like *Mary kissed John*, depending on which entity the speaker wants to emphasize, either *Mary* or *John* can receive a prosodically prominent accent type such as an L+H* (see the study of Baumann & Röhr (2015) in the next paragraph). Another characteristic trait of prominence is that it serves as "structural attractor" (Himmelmann & Primus, 2015: 44; see also Grice & Kügler, 2021). Structural attraction means that prosodically less prominent (optional)

prenuclear or post-nuclear accents are grouped around a prosodically more prominent (obligatory) nuclear pitch accent. That is, the nuclear accent serves as the structural attractor. Thus, prosodic prominence can structure intonational phrases. In summary, prosodic prominence is a relational property that aids in structuring an utterance by putting emphasis on particular parts of the utterance.

To gain further insights into prosodic prominence in German, Baumann & Röhr (2015) examined different pitch accent types and deaccentuation with regard to how prominent they were perceived. For that, they presented participants with the isolated sentence *Sie hat mit der Lana/Lona/Lina telefoniert* ('She was on the phone with Lana/Lona/Lina'; Baumann & Röhr, 2015: 2) and manipulated the pitch accent on the proper noun, *Lana/Lona/Lina*. Participants were then asked to judge how highlighted, thus prominent, the proper name sounded. The results of the study suggested the following scale of perceptual prominence: ø < L* < H+L* < H+!H* < !H* < H* < L*+H < L+H*.[2] More precisely, Baumann & Röhr (2015) found that rises (L*+H, L+H*) were judged as more prominent than falls (H+!H*, H+L*). Furthermore, steep movement (H+L*, H+!H*, L*+H, L+H*) was rated as more prominent than shallow movement (L*, !H*, H*). Generally, high tones (!H*, H*) were judged as more prominent than low tones (L*), while deaccentuation (ø) was considered as least prominent. Baumann & Röhr (2015) provided first insights that pitch accents and deaccentuation differ in terms of their perceived prosodic prominence.

[2] Note that the scale of perceptual prominence includes an !H* and an H* accent, while the GToBI repertoire only accounts for an H* accent. The !H* accent is a variety of the H* accent and only appears in context.

While the outlined study showed how pitch accents differ in terms of their perceptual prominence, it gave no implication of how prosodic prominence might affect language processing. The following section will discuss studies that investigated the effects of prosodic prominence on language processing.

2.2 Prosodic prominence and language processing

Several psycholinguistic studies have investigated how prosodic prominence affects different levels of language processing. By employing either so called on-line methods or off-line methods to examine the effect of prosodic prominence on language processing, the studies tested different effects and levels of language processing accordingly.

So-called off-line language processing studies "measure the consequence of processing, after some or all of the processing has taken place" (Warren, 2012: 162). More specifically, studies have looked at how memory is influenced by prosodic prominence (e.g., Fraundorf et al., 2010; Savino et al., 2020; Kember et al., 2021; Koch & Spalek, 2021; Röhr et al., 2022; Zhou et al., 2024).

For instance, Röhr et al. (2022) tested the influence of prosodic prominence on recall in serial lists in German. Röhr et al. (2022) presented participants with serial lists of nine digits. These nine digits were grouped in triplets, i.e., in chunks of three digits. The digits in the third and sixth position, i.e., at the end of the first two triplets, were either manipulated with an accentual rise, a boundary rise, a boundary fall or were produced neutrally (serving as the control condition). Participants were asked to immediately recall the list after the last digit was auditorily presented. Results showed that the recall of the digits in the experimental conditions (rising accent, rising

boundary tone and falling boundary tone) were more accurate than the recall in the control condition. Moreover, the rising manipulation was more accurate than the falling manipulation. Röhr et al. (2022) argued that intonational rises attract more attention compared to intonational falls and therefore digits that were manipulated with an intonational rise were recalled better.

Additionally, a study by Zhou et al. (2024) investigated effects of prosodic prominence on word recognition memory of words and pseudowords in Dutch. Participants were presented with lists of words and pseudowords that were either recorded carrying an L+H* (prosodically more prominent) or an H* (prosodically less prominent) accent. Zhou et al. (2024) found that prosodically prominent words were recognised better. They argued that this benefit for recognition memory of prosodically prominent words was due to an enhanced semantic processing, i.e., a stronger semantic representation was generated.

The facilitatory effect of prosodic prominence on word recall and word recognition memory in lists also persists in studies that test the recognition memory of words embedded in sentences or brief discourses (Fraundorf et al., 2010; Kember et al., 2021). Fraundorf et al. (2010) investigated the role of two differently prosodically prominent accent types, L+H* and H*, on recognition memory in American English. In English, the accent type L+H* is considered to prototypically show contrastive focus while the accent type H* is considered to prototypically introduce new information in broad focus (see Pierrehumbert & Hirschberg, 1990). In the study of Fraundorf et al. (2010), participants first listened to pre-recorded short stories, each consisting of one context sentence and one experimental sentence, such as “Both the British and the French biologists had been searching Malaysia and

Indonesia for the endangered monkeys. Finally, the British spotted one of the monkeys in Indonesia and planted a radio tag on it." (Fraundorf et al., 2010: 371; highlighting my own). In the experimental sentences, either the first or the second target word was manipulated with an L+H* accent and the other one with an H* accordingly. The second part of the experiment was a forced-choice recognition memory task, where participants had to decide whether the word on the screen had appeared in one of the previously auditorily presented sentences or not. Fraundorf et al. (2010) found that target words manipulated with an L+H* were remembered better than target words that received an H*. The authors argued that the L+H* accent on the target word facilitated encoding of the target word, resulting in an improved memory thereof.

Similar results were found by Kember et al. (2021). They tested the effects of prosodic and syntactic prominence, as well as the combination of these two types of prominence, on word recognition memory in Australian English. Each experimental sentence, such as "It was the noise that kept the kids awake at night.", was introduced by a context question, either "What was keeping the kids awake at night?" or "Who was the noise keeping awake at night?" (Kember et al., 2021: 420; highlighting my own). Depending on the context question, the syntactic prominence of the first target word (*noise*) changed from syntactically prominent to syntactically non-prominent, respectively. Kember et al. (2021) used a high pitch accent to manipulate prosodic prominence. This accent was either on *kids* (in the condition 'prosodic prominence') or on *noise* (in the condition 'syntactic and prosodic prominence'). After each block of sentences, participants subsequently saw one word at a time on the screen and had to indicate whether they had heard the word or not. Kember et al. (2021) found that participants remembered the target words better when they were prosodically

prominent. The authors attributed the better recognition memory of prosodically prominent words to facilitated lexical processing due to prosodic prominence.

Taken together, the results of the aforementioned studies suggest that prosodic prominence aids storing lexical items in memory. Furthermore, the results imply that listeners pay more attention to prosodically prominent entities, suggesting that prosodic prominence facilitates word recognition memory in both short discourses as well as in serial recalls.

Facilitatory effects of prosodic prominence have also been found in studies that have investigated on-line language processing. On-line tasks "measure processing as it happens" (Warren, 2012: 162). More specifically, studies have investigated how prosodic prominence influenced the search of referents in visual-world tasks (e.g., Weber et al., 2006; Chen et al., 2007; Ito & Speer, 2008; Braun & Biezma, 2019) or word identification in monitoring studies (e.g., Cutler & Foss, 1977; Cole & Jakimik, 1980; Cutler & Swinney, 1987; McAllister, 1991; Steffman & Zhang, 2024).

For instance, eye-tracking studies provide evidence that prosodically prominent accent types facilitate the search of referents in visual-world tasks (e.g., Weber et al., 2006; Chen et al., 2007; Ito & Speer, 2008; Braun & Biezma, 2019). Weber et al. (2006) applied a visual-world paradigm where they presented German participants with four different pictures, i.e., a first referent (*purple scissors*), a second referent (the target referent; *red scissors*), a non-contrastive referent (*red vase*) and a distractor (*green clock*). Participants were instructed to click on the purple scissors, with *scissors* bearing an H* accent. After that, participants were instructed to click on the red scissors, with either *red* or *scissors* bearing an L+H* accent. Fixations to the target referent were faster when the adjective was presented with an L+H* compared to

when the accent was on the noun. Weber et al. (2006: 386) argued that the participants "exploited accents on preceding adjectives rapidly enough to anticipate target referents even before the referent noun was mentioned".

Adding on this, Ito and Speer (2008) conducted a similar study but instead of using a visual-world paradigm, they conducted an instructed visual search task with English-speaking participants. Participants were instructed to decorate a holiday tree with ornaments while wearing a head-mounted eye-tracker. The ornaments were mounted on a vision board in different cells, each cell containing the same type of ornament in different colours. Participants heard instructions like "Hang the green drum." followed by "Now hang the blue drum." (Ito & Speer 2008: 545) and were asked to carry out the task. The results showed more frequent fixations and an increase of early fixations to the target cell, i.e., the cell where the target referent was mounted, when the adjective was manipulated with an L+H* accent compared to when the noun bore the L+H* accent. Ito and Speer (2008) followed Weber et al. (2006) in their argumentation that the contrast-indicating L+H* accent on the adjective let the participants anticipate that the following noun is the same type of ornament than the one in the first sentence.

In sum, participants found it easier to find the target referent in both a visual-world paradigm and a real-life instructed search task. Thus, the results of both studies showed that the use of the prosodically prominent accent type L+H*, here used in its function of signalling contrast, facilitated language processing.

Studies have also investigated how prosodic prominence influences the identification of words, phonemes or mispronunciations. Unlike the aforementioned studies, these studies looked at isolated sentences. For instance, Cutler & Foss (1977)

examined the effect of stress on language processing by employing a phoneme-monitoring task. Participants were asked to listen for target phonemes in carrier words that were embedded in isolated sentences. For example, participants were asked to listen for a /b/ at the beginning of a word. Before the presentation of a sentence, a target phoneme was defined. Participants were asked to push a button as soon as they heard a word that started with the previously defined target phoneme. The word starting with the target phoneme either bore the main stress of the sentence, i.e., the word was prosodically prominent, or the main stress was elsewhere in the sentence. Target phonemes were identified faster when they were at the onset of words that received the main stress compared to when they appeared in words that did not bear the main stress. Cutler & Foss (1977) argued that this was because listeners' attention was directed towards the word bearing the main sentence stress.

These results were confirmed in a word-monitoring study conducted by Cutler & Swinney (1987). Participants had to listen to pre-recorded, isolated sentences and were asked to push a response key as soon as they identified a previously defined target word. Either the target word carried the primary sentence accent (i.e., the target word was prosodically prominent) or the primary sentence accent was elsewhere in the sentence (i.e., the target word was not prosodically prominent; e.g., *The nurse brought a* ***clean*** *towel and took away the dirty one*; Cutler & Swinney, 1987: 151; highlighting my own, bold indicating the target word, underlining indicating the alternative primary sentence accent). Participants identified the target word faster when it carried the primary sentence accent compared to when the primary sentence accent was elsewhere. Cutler & Swinney (1987: 154) argued that words carrying the

primary sentence accent are “acoustically clearer”, leading to the faster identification times thereof.

A somewhat related study by Cole & Jakimik (1980) provides further evidence that prosodic prominence facilitates language processing. Cole & Jakimik (1980) investigated the influence of stress on the detection of mispronunciations. Participants were asked to click on a button as soon as they identified the mispronounced word. Mispronunciations were syllable-initial and the phonemes /p/ and /k/ were replaced by /b/ and /g/, respectively. Mispronunciations occurred either in stressed, i.e., prosodically prominent, or unstressed, i.e., prosodically not prominent, words. Participants identified mispronunciations more often when they occurred in stressed words compared to unstressed words. Cole & Jakimik (1980) attributed the higher detection rate of mispronunciations in stressed words to a higher salience of stressed words and to more prominent acoustic features in stressed words and syllables.

A more recent study by Steffman & Zhang (2023) investigated how prosodic prominence, more specifically F0, i.e., the perceived height of an accent, and duration, i.e., the perceived length of a word, influences the perception and categorization of vowels in American English. Steffman & Zhang (2023) found that prosodic prominence facilitated formant perception, i.e., prosodic prominence facilitated distinguishing vowels. The authors argued that F0 (and duration) raised the perceptual salience of the target vowel, providing “a measurable perceptual benefit to the listener” (Steffman & Zhang, 2023: 2605).

Taken together, these studies suggest that prosodic prominence plays a crucial role in on-line language processing. The studies provide evidence that prosodic prominence can facilitate on-line language processing in that the prosodically

prominent entity – such as phonemes, mispronunciations or words – can be identified more easily.[3]

To summarize, off-line studies (e.g., Fraundorf et al., 2010; Savino et al., 2020; Kember et al., 2021; Röhr et al., 2022; Zhou et al., 2024) and on-line studies (e.g., Cutler & Foss, 1977; Cole & Jakimik, 1980; Cutler & Swinney, 1987; Weber et al., 2006; Chen et al., 2007; Ito & Speer, 2008; Braun & Biezma, 2019) have repeatedly shown that prosodic prominence can facilitate language processing. These studies mostly focussed on one or two accent types, and predominantly tested the influence of prosodic prominence in its use of e.g., signalling contrast. However, it has yet to be established if prosodic prominence per se can also affect language processing, i.e., when it is used for highlighting reasons only. While the main focus of the research so far was on facilitatory effects of prosodic prominence, it has yet to be investigated whether these facilitatory effects of prosodic prominence might also come at a prize.

[3] Please note that the term *identification* is used for tasks such as word-monitoring where participants are instructed to listen for/identify previously defined words. The term *recognition* is used for tasks such as word recognition memory where participants first hear sentences and are then presented with particular words and have to decide whether they have heard the word before or not.

3. Research Questions

Chapter 2 summarized recent studies that have investigated the effects of prosodic prominence on specific aspects of language processing. The focus of these studies was either on word identification in word-monitoring tasks (e.g., Cutler & Swinney, 1987), on referent identification in visual-world eye-tracking studies (e.g., Weber et al., 2006; Ito & Speer, 2008), or on word recognition in memory tasks (e.g., Fraundorf et al., 2010; Kember et al., 2021; Zhou et al., 2024). The aforementioned studies found facilitatory effects of prosodic prominence on off-line language processing, i.e., words were recognised and recalled more accurately in word recognition and word recall tasks. Furthermore, the studies found facilitatory effects of prosodic prominence on on-line language processing, i.e., words were identified faster in word-monitoring task and referents were identified faster in visual-world studies.

In most of these studies, prosodic prominence fulfilled a specific function. For instance, prosodic prominence was used to signal, e.g., contrast (e.g., Ito & Speer, 2008; Fraundorf et al., 2010) or focus (Kember et al., 2021). Therefore, it is especially interesting to investigate how prosodic prominence per se, i.e., when it is used without fulfilling any function except for highlighting a word, affects language processing.

Furthermore, while previous studies have focussed on facilitatory effects of prosodic prominence on language processing, it is especially interesting to investigate whether prosodic prominence might also have impairing effects on off-line and on-line language processing. Investigating both facilitatory and possibly impairing effects of prosodic prominence on language processing will give a more complete picture of its influence. Therefore, the central goal of this dissertation is to explore the overall

effects of prosodic prominence on language processing. Specifically, the goal is to examine the following overarching research question:

How does prosodic prominence influence language processing in German?

In order to answer this overarching research question, the following more fine-grained questions will be addressed:

RQ 1.1: Do accent types that vary in their perceptual prominence facilitate on-line language processing to a graded degree?

RQ 1.2: Does prosodic prominence have impairing effects on on-line language processing? If so, do accent types that vary in their perceptual prominence impair on-line language processing to a different degree?

RQ 2: Does prosodic prominence impair off-line language processing?

RQ 3: Are off-line and on-line processing affected differently by prosodic prominence?

In order to answer these research questions, two experiments were carried out. A word-monitoring task was conducted to test the effects of prosodic prominence on on-line language processing (RQ 1.1 and RQ 1.2) and a word recognition memory task was conducted to investigate the effects of prosodic prominence on off-line language processing (RQ 2). Comparing the results of the two studies will hopefully provide an answer for the exploratory question whether off-line and on-line processing are affected differently by prosodic prominence (RQ 3). Finally, these questions aim at

answering the overarching research question of how prosodic prominence influences language processing in German.

RQ 1.1: Do accent types that vary in their perceptual prominence facilitate on-line language processing to a graded degree?

In order to investigate the effects of prosodic prominence on on-line language processing in German, a word-monitoring task, similar to that of Cutler & Swinney (1987), was conducted. Unlike Cutler & Swinney (1987), however, this dissertation did not only test the absence or presence of one accent type. Rather, the goal was to investigate if accent types that vary in their perceptual prominence (e.g., Baumann & Röhr, 2015) would also lead to graded facilitatory effects on on-line language processing. More precisely, two prosodically more prominent accent types (L + H* and L* + H), one prosodically less prominent accent type (L*) and deaccentuation (ø), which is prosodically least prominent, were tested.

It is often argued that prosodic prominence centres attention (see e.g., Himmelmann & Primus, 2015). What does this mean exactly? Posner (1980: 4) argued that attention orienting is "the aligning of attention with a source of input or an internal semantic structure stored in memory". Prosodic prominence is best described as a source of external input that draws the involuntary attention[4] of the listener to the prosodically prominent word. That means that directing attention towards the prosodically prominent word is not in the listener's control but an automatic response

[4] Attention can be drawn exogenously or endogenously (e.g., Knudsen, 2007). Exogenous attention, also known as involuntary or stimulus-driven attention, is directed by an 'external' factor – such as a sudden loud noise –, while endogenous attention, also known as voluntary or goal-directed attention, is directed by an 'internal' factor – such as concentrating on a task (e.g., Gamer, 2019).

to the external stimulus, i.e., to prosodic prominence. Furthermore, James (1890: 403 f.) defined attention as the "taking possession by the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought" and further argued that this implies a "withdrawal from some things in order to deal effectively with others". This entails that when attention, and thereby processing resources, are directed towards the prosodically prominent word, the processing of words that are not in focus might get neglected.

Evidence that prosodic prominence indeed draws attention comes from a study by Lialiou et al. (2024) using Event-Related Potentials (ERP). The authors used the oddball paradigm to examine the influence of rises and falls on language processing when they appeared unexpectedly in a sequence of repetitive auditory stimuli.[5] The main finding was that the rising pitch accent L+H*, being the prosodically most prominent accent type in German (Baumann & Röhr, 2015), "takes on a special role in attracting involuntary attention" (Lialiou et al., 2024: 1118). Lialiou et al. (2024) based this on the fact that the L+H* evoked the largest mismatch negativity (MMN). The MMN is an automatic neurophysiological response that reflects an involuntary attention switch towards an unexpected change in sound (e.g., Näätänen, 1992; Näätänen et al., 2019). While Lialiou et al. (2024) do not make claims about language processing, the results suggest that prosodic prominence, by orienting attention, might also facilitate language processing.

How exactly could this facilitative language processing look like? A variety of psycholinguistic models has been proposed to explain how auditory word recognition[6]

[5] The oddball paradigm is used to study brain responses to unexpected stimuli, so called deviants, within a stream of repetitive standard stimuli.

[6] Please note that speech comprehension models use the term *recognition* in the sense of *identification*.

works (e.g., Marslen-Wilson & Welsh 1978; McClelland & Elman 1986; Norris 1994; Cutler & Clifton, 2000). Most of these models largely overlap in the following three stages: initial contact, selection and integration (see e.g., Dahan & Magnuson, 2006). During the initial contact stage, words that share the same onset get activated: For reasons of simplification, say that upon hearing the onset /cæ/ the words *candle*, *cat* and *cabin* get activated. The more the auditory input unfolds, the more lexical items get excluded, until the correct lexical item is chosen. That is, in our scenario, upon hearing /cæb/, *candle* and *cat* get excluded and *cabin* is chosen. This stage of auditory word recognition is called selection. During the integration stage, the chosen lexical item is integrated into the discourse, taking the semantic and syntactic structure of the input into account. This dissertation proposes that prosodic prominence facilitates the selection stage of auditory word recognition. Prosodically prominent words are hyperarticulated (e.g., de Jong, 1995) which is why it might be easier to differentiate between words that share the same onset or sound similar in general. This might be due to a more rapid filtering out of candidates or to a smaller initial cohort in the selection stage to start with. Consequently, it is likely that prosodically prominent words are more accessible for the listener and therefore get selected faster.

Indeed, as shown by Cutler & Swinney (1987), accented, i.e., prosodically prominent, words were identified faster than unaccented, i.e., not prosodically prominent, words. Given the assumption that prosodic prominence draws attention and given the scale of perceptual prominence by Baumann & Röhr (2015), accent types that differ in their perceptual prominence might also influence identification times in a word-monitoring task, i.e., on-line language processing, differently. The more prosodically prominent an accent type, the more attention it might draw. More

specifically, this means that the rising accent types L*+H and L+H* are expected to draw attention more efficiently than the low accent type L* or deaccentuation, ø, because the accent types L*+H and L+H* are prosodically more prominent. Consequently, this would mean that target words that bear either L+H* or L*+H pitch accents should be identified faster in a word-monitoring task than target words that are either deaccented or manipulated with the accent type L*, because prosodic prominence may facilitate the selection process. Thus, prosodic prominence might facilitate on-line processing to a graded degree. Therefore, the following graded scale of identification times could be expected: ø > L* > L*+H > L+H*. To examine this graded effect Study 1, which will be reported in Chapter 4, was conducted.

RQ 1.2: Does prosodic prominence have impairing effects on on-line language processing? If so, do accent types that vary in their perceptual prominence impair on-line language processing to a different degree?

Drawing attention might bind processing resources. This implies that less processing resources might be available for processing words that follow a prosodically prominent word. Evidence for this comes from the ERP-study by Lialiou et al. (2024: 1117) that found that besides attracting the most attention, rising pitch accents also "demand more attention resources". If more resources are spent, less resources can be laid out for the subsequent word, as cognitive resources are limited.

As outlined for RQ 1.1, prosodic prominence, by drawing attention, might facilitate the stage of selection that is introduced overlappingly in speech comprehension models. If the selection process is facilitated, a more in-depth processing of the word might take place, for instance through a deeper semantic or

phonological processing, i.e., (co-)activation of semantically or phonologically related words. That is, more information relating to a prosodically prominent word might get (co-)activated which might enhance the encoding and processing of the prosodically prominent word. This is likely to consume processing resources. Consequently, it is possible that the facilitation of selecting the correct lexical item might also be costly because a more in-depth processing of the prosodically prominent word happens. Thus, less attention and processing resources can be spent on the word that follows a prosodically prominent word.

If prosodically prominent accent types such as L+H* or L*+H indeed allocate more attention, as suggested for instance by Lialiou et al. (2024), it is possible that they also bind more processing resources than accent types that are low in prosodic prominence (L*) or deaccentuation (ø), because prosodically more prominent accent types might lead to a more in-depth processing of the words. Hence, in a word-monitoring task, target words that follow a word with an accent type that is high in prosodic prominence, such as the rises L*+H and L+H*, should be identified more slowly than target words that follow an entity that bears an accent type that is low in prosodic prominence, such as L* or that is deaccented, ø. Consequently, prosodic prominence might affect on-line processing to a graded degree. More precisely, the following graded scale of identification times could be expected: ø < L* < L*+H < L+H*. Study 1, which will be reported in Chapter 4, will examine this question.

RQ 2: Does prosodic prominence impair off-line language processing?

Research so far has focussed on facilitatory effects of prosodic prominence on off-line language processing. Studies have shown that the recognition memory of words

benefitted from prosodic prominence because prosodically more prominent words were remembered better than prosodically less prominent words (e.g., Fraundorf et al., 2010; Kember et al., 2021; Zhou et al., 2024). Following the line of argumentation outlined for RQ 1.1 and 1.2, it is possible that prosodic prominence enhances the processing of so-marked words which might lead to a better recognition memory thereof. Research so far, however, has neglected to look at the processing of words that follow prosodically prominent words.

As outlined for RQ 1.2, processing prosodic prominence is assumed to require processing resources that are bound and which are consequently lacking for processing an immediately following word. Thus, less processing resources can be spent on the following word. If less processing resources are spent on a word, the processing of this word might be shallower. A likely consequence of this is that the memory of this word might be impaired and the retrieval of the word is likely to be worse in a word recognition memory task. Thus, off-line language processing might be impaired by prosodic prominence. To test this, a word recognition memory task was conducted. Specifically, a target word that follows a prosodically prominent word, i.e., a word that carries an L+H* should be recognised less accurately than a target word that follows a word that is deaccented, ø, i.e., a word that is low in prosodic prominence. To examine this question, Study 2 which will be reported in Chapter 5 was conducted.

RQ 3: Are off-line and on-line processing affected differently by prosodic prominence?

Previous research has shown facilitatory effects of prosodic prominence on both off-line language processing and on-line language processing when the prosodic

prominence of the target word was manipulated (see e.g., Cutler & Swinney, 1987 or Zhou et al., 2024). Therefore, no differences in the effects of prosodic prominence on on-line language processing and off-line language processing are expected.

However, research so far has not yet investigated the effects of prosodic prominence when the word preceding the target word was prosodically manipulated. Therefore, this part of the research question is rather exploratory. Given the assumption that prosodic prominence binds processing resources (RQ 1.2 and RQ 2), both on-line and off-line language processing of the following word should be impaired. Thus, off-line and on-line language processing are not expected to be influenced differently by prosodic prominence.

4. Study 1: Prosodic prominence does not influence word identification times

Study 1a: Zeyer, Barbara & Penke, Martina. 2023. The processing of prosodic prominence in German. In Skarnitzl, Radek & Volín, Jan (eds.), *Proceedings of the 20th International Congress of Phonetic Sciences*. 4071–4075. Prague, Czech Republic: Guarant International.

Study 1b: Zeyer, Barbara & Penke, Martina. 2024b. Prosodic prominence does not speed up word recognition in a word monitoring task with German adult speakers. *Glossa: a journal for general linguistics* 9(1).

Study 1a was published as part of a conference proceedings and only discusses one part of the data, namely the part where the target word was prosodically manipulated. Study 1b discusses the whole data set, where either the target word or the word preceding the target word was prosodically manipulated and will therefore be the base of the following discussion in Chapter 6.

Background

Little research has been done on the topic of how prosodic prominence influences on-line language processing, more specifically word identification. Most importantly, Cutler & Swinney (1987) found evidence that participants identified words faster

when they were prosodically prominent. However, Cutler & Swinney (1987) tested the presence and absence of one accent in their study. Given the fact that accent types differ with regard to their perceptual prominence (see Baumann & Röhr, 2015), the question arises whether accent types differing in their perceptual prominence would also lead to a graded effect of prosodic prominence on word identification in a word-monitoring task. The aim of the present study was to investigate if a graded effect of prosodic prominence would also lead to a graded effect of prosodic prominence on word identification in a word-monitoring task.

The hypothesis that prosodic prominence binds processing resources led to the assumption that prosodic prominence might also bind processing resources, which consequently might be lacking for processing subsequently presented linguistic material. While previous research has focused on the effects of prosodic prominence on target word identification when the target word itself received prosodic manipulation, research has not yet investigated the effects of prosodic prominence on target word identification when the word preceding the target word received prosodic manipulation. Therefore, the second aim of this study was to fill this research gap, namely to investigate if prosodic prominence binds processing resources and thus might slow down language processing when manipulated on the word preceding the target word.

Methods

58 students participated in this study. Nine participants had to be excluded from statistical analyses because they were either brought up bilingually (eight) or they misunderstood the task (one). This left 49 participants (female: 34; male: 15).

Participants' mean age was 23 years (range: 18–31 years). None of the participants reported any hearing, speech or visual impairments and reported to be neurotypical.

Participants took part in a word-monitoring task to test the immediate effect of prosodic prominence on on-line language processing. In a word-monitoring task, participants are asked to push a button as soon as they identify a previously defined target word in an auditorily presented sentence. Trial structure was as follows (see also Figure 1): First, a fixation cross was in the centre of the computer screen for 700 ms. The fixation cross was followed by a target word that appeared in the middle of the computer screen and remained visible for 1500 ms. After 1500 ms, the screen went blank and a sentence was presented auditorily through headphones. The participants were instructed to push a button on a response box (SR Research) as soon as they identified the previously defined target word in the sentence. The reaction time measurement started with the onset of the target word and ended when the participant pushed the button. A timeout for participants' reactions was set at 4000 ms.

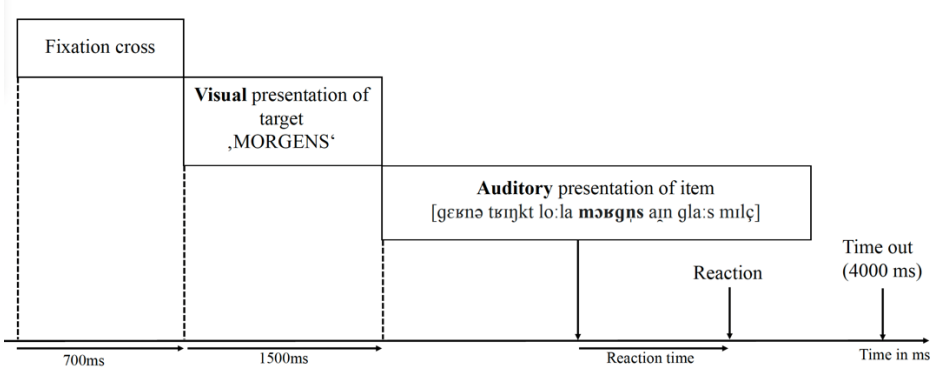


Figure 1: Example of an experimental trial of the word-monitoring task.

Seven different experimental conditions were tested in this experiment in order to examine if prosodic prominence leads to a graded effect on on-line language

processing: L+H*, L*+H and L* either on the target word or on the word preceding the target word and ø on the target word and on the word preceding the target word (see Figure 2). This last condition served as the baseline condition.

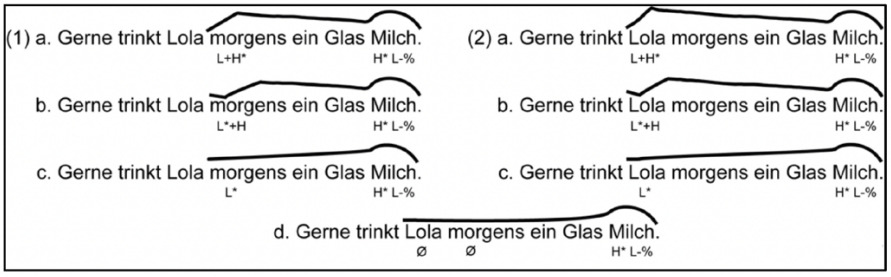


Figure 2: Stylized intonation contour of an experimental sentence. In conditions 1a-c the target word *morgens* ('in the morning') is prosodically manipulated, while in conditions 2a-c the word preceding the target word *Lola* is prosodically manipulated. In condition 1/2d, both the target word and the preceding word are prosodically manipulated.

Ten unique sentences for each experimental condition were constructed, using the following syntactic structure: adverb – verb – subject – target word – object. That is, the target word always appeared in the fourth position, directly following the sentential subject. An example sentence is illustrated in (1), bold indicates the target word. Target words were bi-syllabic, trochaic adverbials of time, of space, of reason or of modality and were controlled for their word frequency, their number of phonemes and their duration in ms. Furthermore, the written sentences were rated with regard to their naturalness. Sentences were evenly distributed across the experimental groups taking into consideration the mean word frequency of the target word, the mean duration in ms of the target word, the mean number of phonemes of the target word and the naturalness of the written sentences.

(1)	*Gerne*	*trinkt Lola*	***morgens***	*ein Glas Milch.*
	Happily	drinks Lola	in the morning	a glass of milk

Additionally, 70 filler sentences were constructed. These filler sentences were variable in their syntactic structure and in the placement of the target word within the sentence. Some of the filler sentences included the onset of the target word prior in the sentence, some did not include a target word.

Furthermore, a post-hoc study was conducted to test if the difference between the prosodic manipulations L+H* and ø were perceivable in the experiment. Participants were instructed to rate how highlighted either the target word or the preceding word sounded on a 5-point Likert scale. In total, participants listened to 30 sentences: ten sentences in the condition where the word preceding the target word was manipulated with an L+H*, ten sentences in the condition where the target word was manipulated with an L+H* and ten sentences where both the target word and the preceding word were deaccented, ø. 36 students participated in the study. In total, nine had to be excluded because they either did not finish the task (four) or acquired German after the age of six years (five). This left 27 participants (female: 23: male: 3; diverse: 1). Their mean age was 23 years (range: 19–33).

Results and discussion

Table 2 summarizes the mean identification times for the seven different experimental conditions: L+H* on the target word or on the preceding word, L*+H on the target word or the preceding word, L* on the target word or the preceding word and ø on the target word and the preceding word.

Position of manipulation	Prosodic manipulation	Mean reaction time in ms	SD in ms
on the target word	L+H*	553	145
	L*+H	544	160
	L*	563	161
	ø	545	139
on the word preceding the target word	L+H*	552	143
	L*+H	515	141
	L*	549	167
	ø	545	139

Table 2: Mean reaction times of target word identification in ms in the conditions L+H*, L*+H, L* and ø on the target word or on the preceding word.

The predicted scale of identification times in the conditions where the target word was prosodically manipulated (L+H* < L*+H < L* < ø) was not confirmed by the results. A linear mixed effects regression model using the lme4 package (Bates et al., 2015) in R (R Core Team, 2021) was computed and did not yield significance, suggesting that there was no facilitatory effect of prosodic prominence on on-line language processing. Pairwise comparisons between the three accent types (L+H*, L*+H, L*) and the baseline condition (ø) did not yield significance, suggesting that there was no facilitatory effect of prosodic prominence on word identification. To test if there was a graded effect of prosodic prominence, pairwise comparisons between accent types (L+H* vs. L*+H, L+H* vs. L*, and L*+H vs. L*) were conducted. The

results of all of these comparisons were non-significant, suggesting that there was no graded effect of prosodic prominence on on-line language processing.

Likewise, the results did not confirm the predicted scale of identification times (L+H* > L*+H > L* > ø) in the condition where the word preceding the target word was prosodically manipulated. A linear mixed effects regression model using the lme4 package (Bates et al., 2015) in R (R Core Team, 2021) did not yield significance, suggesting that there was no impeding effect of prosodic prominence on on-line language processing. Pairwise comparisons between the three accent types (L+H*, L*+H, L*) and the baseline condition (ø) did not yield significance, suggesting that there was no impeding effect of prosodic prominence on word identification. To test the anticipated graded effect of prosodic prominence, pairwise comparisons between accent types (L+H* vs. L*+H, L+H* vs. L* and L*+H vs. L*) were conducted. The results of these comparisons were not significant, suggesting that there was no graded effect of prosodic prominence on on-line language processing.

An interaction between accent type and position was predicted: A prosodically prominent accent type (L+H* and L*+H respectively) on the target word should lead to faster identification times of the target word compared to when the same prosodic manipulation was on the subject preceding the target word. The conducted model and pairwise comparisons for the interaction between accent type and position (L+H* and L*+H on the target words compared to on the subject preceding the target word, respectively) did not yield significance, suggesting that there is no interaction between accent type and position.

For the post-hoc study, mixed effects ordinal model using the ordinal package (Christensen, 2023) in R (R Core Team 2021) was conducted to compare the

prominence ratings between experimental conditions. Results revealed that the condition where the target word was manipulated with an L+H* was rated significantly more prominent than the condition ø ($ß = -4.8$, $p < .0001$). Likewise, the condition where the word preceding the target word was manipulated with an L+H* was rated significantly more prominent than the condition ø ($ß = -4.4$, $p < .0001$). This suggests that the difference between the condition L+H* and ø were indeed perceivable for the participants, suggesting that this was not a decisive factor that no effect of prosodic prominence on word identification times was found.

In conclusion, Study 1 could not replicate the results by Cutler & Swinney (1987) who found a facilitatory effect of prosodic prominence on word identification times when the target word was prosodically prominent. Furthermore, no graded facilitatory effect of prosodic prominence on word identification times was found in the conditions where the target word was prosodically manipulated. Likewise, the results did not show a (graded) effect of prosodic prominence when the word preceding the target word was prosodically manipulated.

Study 2, presented in Chapter 5, will look at the influence of prosodic prominence on off-line language processing, more precisely targeting the question whether prosodic prominence affects word recognition memory.

5. Study 2: The costs of processing prosodic prominence

Zeyer, Barbara & Penke, Martina. 2024a. Prosodic prominence and its hindering effect on word recognition memory in German. *Proceedings of the 12th Speech Prosody*. 1135–1139. Leiden, Netherlands.

Background

Word recognition memory and word recall studies have repeatedly shown that prosodically prominent words are recalled better compared to words that are not prosodically prominent (see e.g., Fraundorf et al., 2010; Savino et al., 2020; Kember et al., 2021; Röhr et al., 2022; Zhou et al., 2024). However, research has not yet investigated whether the processing of prosodic prominence is also costly. The goal of the current study was to investigate this open question by examining the effects of prosodic prominence on off-line language processing when the word preceding the target word was manipulated with regards to its prosodic prominence. To this end, a word recognition memory task was conducted where the word directly preceding the target word was either manipulated with the highly prosodically prominent accent type L+H* or it was deaccented, ø, i.e., low in prosodic prominence.

Methods

56 participants took part in this study. Two participants had to be excluded because they reported to be simultaneous bilinguals. All remaining participants had German as their first language. Furthermore, none of the participants reported any hearing, speech or visual disorders and all participants reported to be neurotypical. Participants' mean age was 24 years (range: 18–39 years). One participant identified

as diverse, eleven participants reported to identify as male and 42 participants identified as female.

A word recognition memory task was conducted to test the effect of prosodic prominence on off-line language processing. In this word recognition memory task, participants first listened to 10 auditorily presented sentences. In a second part, ten target words subsequently appeared on the screen and participants had to indicate through a button push if they had heard the target word in one of the previously presented sentences or not. The exact experimental structure was as follows (see also Figure 3): First, ten pre-recorded sentences were auditorily presented with an approximately four seconds long pause in between sentences. Then, ten words subsequently appeared at the centre of the computer screen. The target words were preceded by a fixation cross that remained visible on the screen for 750 ms. For each word, participants had to indicate by pressing a button on a response box (SR Research) if they had heard the word in one of the sentences or not. If so, they had to push a green button with their dominant hand. If not, participants had to push a pink button with their non-dominant hand.

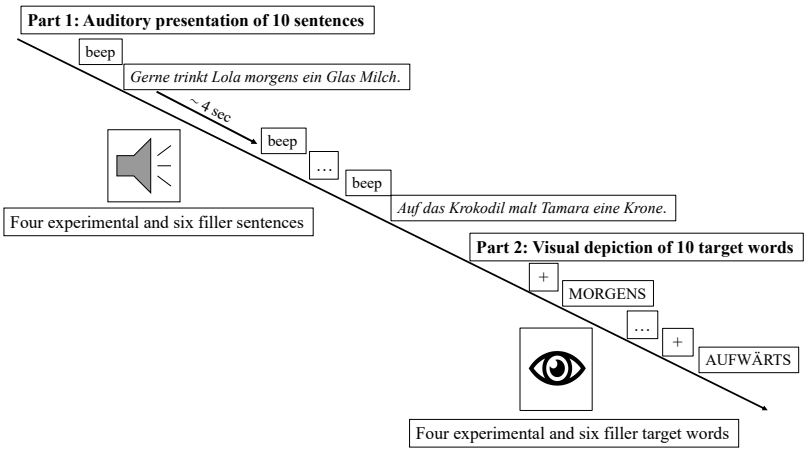


Figure 3: Experimental set up of the word recognition memory task.

Two different experimental conditions were tested in this experiment: L + H* and ø on the word preceding the target word. Deaccentuation, ø, served as the baseline condition. 20 unique sentences for each experimental condition were constructed, using the following syntactic structure: adverb – verb – subject – target word – object. That is, target words always appeared in the fourth position, directly following the sentential subject. An example sentence is illustrated in (2), bold indicates the target word for which recognition memory was tested, underlining indicates the word that was prosodically manipulated. Target words were bi-syllabic, trochaic adverbials of time, of space, of reason or of modality and were controlled for their word frequency, their number of phonemes and their duration in ms. Furthermore, the written sentences were rated with regard to their naturalness. Sentences were evenly distributed across the experimental groups taking into consideration the mean word frequency of the target word, the mean duration in ms of the target word, the mean number of phonemes of the target word and the naturalness of the written sentences.

(2)	*Gerne*	*trinkt*	*<u>Lola</u>*	***morgens***	*ein Glas Milch.*
	Happily	drinks Lola		in the morning	a glass of milk

Additionally, 60 filler sentences were constructed. 20 of these filler sentences were constructed following the syntactic structure of the experimental sentences. These filler sentences also contained a target word for which recognition memory was tested. 40 filler sentences were variable in their syntactic structure and did not contain a target word.

Results and discussion

The accurate recognition rate of the target word in the condition deaccentuation, ø, on the word preceding the target word was expected to be higher than in the condition L+H* on the word preceding the target word. The results showed that the accurate recognition rate in the condition deaccentuation, ø, on the word preceding the target word was at 65.8 %. In the condition L+H* on the word preceding the target word, the accurate recognition rate was 53.7 %. A linear mixed effect logistic model using the lme4 package (Bates et al., 2015) in R (R Core Team, 2021) was conducted and yielded a significant effect for experimental condition ($p = .007$), suggesting an impeding effect of prosodic prominence on off-line language processing.

The findings of this study showed that the highly prosodically prominent accent type L+H* on the word preceding the target word led to a less accurate recognition memory of the target word than the low prominent deaccentuation. This suggests that prosodic prominence can impede the processing of target words that directly follow prosodically prominent words. As a result, these words were remembered worse. This suggests that prosodic prominence is not only facilitatory in nature but can also hinder language processing.

6. Discussion

This chapter will discuss the results of the previously presented studies with regard to the question whether and, if so, how prosodic prominence influences language processing in German. The results of the first study, discussed in Chapter 4, showed that prosodic prominence did not influence on-line language processing in German. Specifically, prosodic prominence neither facilitated word identification when manipulated on the target word nor impeded word identification when manipulated on the word preceding the target word. Contrary to this, the results of the second study, discussed in Chapter 5, showed an impeding effect of prosodic prominence on off-line language processing. More precisely, prosodic prominence on the word preceding the target word led to a less accurate recognition memory of the target word. The discussion will therefore be divided into three parts. Section 6.1 (RQ 1.1 and RQ 1.2) will discuss the effects of prosodic prominence on on-line language processing. The effects of prosodic prominence on off-line language processing will be discussed in Section 6.2 (RQ 2). Limitations of the studies as well as outlooks for future studies will be addressed in each section. Section 6.3 will discuss the question why an effect of prosodic prominence on off-line language processing was found while there was no effect of prosodic prominence on on-line language processing (RQ 3).

6.1 Prosodic prominence does not affect on-line language processing (RQ 1.1, RQ 1.2)

The results of the word-monitoring task did not show a significant difference in reaction times between experimental groups, neither in the conditions where the target word was prosodically manipulated nor in the conditions where the word

preceding the target word was prosodically manipulated. It was hypothesized that prosodic prominence draws attention, thereby leading to faster word identification times in a word-monitoring task when manipulated on the target word. The results of Study 1, however, did not show facilitatory effects of prosodic prominence on on-line language processing. Furthermore, prosodic prominence was assumed to bind processing resources, thereby leading to slower word identification times in a word-monitoring task when manipulated on the word preceding the target word. However, this assumption could not be validated by the results of Study 1. Thus, contrary to the expectations, this suggests that prosodic prominence might not influence on-line language processing in German.

Study 1 was designed to replicate the results found by Cutler & Swinney (1987). They conducted a word-monitoring task with English-speaking participants and found a facilitatory effect of prosodic prominence on on-line language processing, as the participants identified the target word faster when it was accented, i.e., prosodically prominent, compared to when the target word was deaccented, i.e., prosodically not prominent. This is in contrast to the findings of Study 1. Cutler & Swinney (1987) manipulated the main sentence accent, whereas in Study 1, the accent in prenuclear position was prosodically manipulated. The status of prenuclear accents is subject to an on-going debate: While some scholars argue that prenuclear accents are produced for ornamental and rhythmical reasons only, therefore not conveying meaning (Büring, 2007; Calhoun, 2010; Jagdfeld & Baumann, 2011; Kapatsinski, et al., 2017; Baumann et al., 2021), other researchers argue that prenuclear accents do serve some function (Féry & Krüger, 2008; Braun & Biezma, 2019; Roessig, 2023). Féry & Krüger (2008), for instance, found that prenuclear accents changed depending on the

information status of the word in the nuclear position. Adding on this, Braun & Biezma (2019) conducted a visual-world study where they manipulated the prenuclear accent type on the sentential subject with either an L+H* or an L*+H. Results revealed that a prenuclear L*+H accent on the subject increased fixations to the contrast alternative displayed on the screen. Braun & Biezma (2019) suggested that prenuclear accents are not purely ornamental but serve some function such as activating contrast alternatives, thereby conveying meaning. Contrary to this, Kapatsinski et al. (2017) found that pitch peaks at the end of an utterance, which are equivalent to nuclear accents, are considered more important than pitch peaks in the beginning of an utterance. In addition to this, Jagdfeld & Baumann (2011) found that participants were less sensitive to prosodic manipulation in prenuclear position compared to nuclear position in a prosodic judgement task. In line with this, it seems reasonable to assume that word identification times in the word-monitoring task were not affected by the prosodic manipulation because it occurred in the prenuclear position. However, recall that a post-hoc study was conducted to examine whether the difference between words that were manipulated with an L+H* and words that were deaccented was perceivable for participants. The results revealed that participants perceived the difference between an L+H* and ø in the experimental stimuli, suggesting that not the prenuclear position per se was accountable for the lack of an effect of prosodic prominence on on-line language processing. This is also consistent with the results of Study 2, where prosodic prominence impaired the recognition memory of the target word that followed a prosodically prominent word in prenuclear position (for a more detailed discussion, see Section 6.3).

What is more, contrast-signalling accent types such as L+H* can co-activate contrast alternatives even when these alternatives are not explicitly mentioned in the discourse (e.g., Rooth, 1985; Watson et al., 2008; Braun & Tagliapietra, 2010). Watson et al. (2008), for instance, compared in their visual-world eye-tracking study the fixations evoked by the accent types L+H* (prototypically signalling a contrast relationship) and H* (prototypically introducing a new referent). First, Watson et al. (2008) established contrast pairs by presenting two referents (*Click on A and B*). Then one of the referents was made more salient (*Move B to the right of C*). Finally, they either introduced a new referent or re-mentioned a referent from the first sentence (*Now, move A/D below E*). The referents in the last sentence (*A* and *D*) were either manipulated with the accent L+H* or with the accent H*. Watson et al. (2008) found that the accent L+H* led to more looks to the contrast alternative (*A*), whereas the accent type H* evoked an equal number of looks to the new referent (*D*) and the contrast alternative (*A*). Additionally, Braun & Tagliapietra (2010) examined how contrastive intonation affected language processing in a cross-modal priming study. For that, Braun & Tagliapietra (2010: 1041) first presented a pre-recorded sentence (e.g., *In Florida he photographed a flamingo*) either with or without a contrastive accent on the sentence-final word. Subsequently a word that was either a contrast alternative to the last word in the sentence (e.g., *pelican*), non-contrastive (*pink*) or a control word (*celebrity*) appeared on the screen. Participants had to indicate whether the word they saw on the screen was a real word or not. The contrast alternative *pelican* was identified faster as a word when the last-mentioned entity of the sentence, i.e., *flamingo*, received a contrastive accent. Braun & Tagliapietra (2010) argued that although the contrast alternatives were not explicitly mentioned, as the sentences

were produced in isolation, contextual alternatives became activated, thus more salient for the participants. The results of these studies suggest that the contrast-signalling accent type L+H* activated non-mentioned contrast alternatives. Consequently, this implies that in Study 1 the rising accents (L*+H and L+H*) could have triggered the activation of contrast alternatives even though the sentences were presented in isolation and no context was explicitly given. This could hence mean that, when the prosodic manipulation was on the target word, the activation of contrast alternatives of the target word might have slowed down language processing because not only the actual adverbial but also co-activated contrast alternatives would have to be processed. This higher demand of processing resources might have cancelled out the anticipated facilitatory effects of prosodic prominence on target word identification when the target word was prosodically prominent. This could explain the missing effect of prosodic prominence on on-line language processing in the first part of Study 1 where the target word was prosodically manipulated. Conversely, a rising accent on the word preceding the target word should slow down the identification times of the target word for two reasons: First, as outlined in Chapter 3, prosodic prominence is assumed to bind processing resources. These processing resources may no longer available for parsing the target word that is preceded by the prosodically prominent word. Additionally, if rising accents trigger the co-activation of contrast alternatives, the identification times of the target word should also be slowed down because the participants would encounter additional costs of entertaining not just the actual mentioned entity but also co-activated contrast alternatives. Both effects together should lead to slower reaction times compared to the baseline condition (ø) where neither processing resources are bound nor contrast

alternative co-activated. However, the identification times in these conditions (L* + H and L + H*) were not significantly slower than in the baseline condition (ø). The reaction times in the condition L* + H and L + H* were in fact numerically faster than in the condition ø. Therefore, the possible co-activation of contrast alternatives was not a decisive factor that could explain the lack of an effect of prosodic prominence on on-line language processing.

Another reason why Study 1 could not find an effect of prosodic prominence on on-line language processing could be that the intonation contour might have been unnatural, therefore possibly slowing participants down. Braun et al. (2011) conducted a word-monitoring task with Dutch participants where they manipulated the intonation contour of sentences. First, the sentences were recorded informally, as if uttered in spontaneous speech. In a second step, the recordings were sine-inverted, resulting in an unfamiliar intonation contour for Dutch speakers. The results showed that the participants identified target words that were embedded in sentences with an unfamiliar intonation contour significantly more slowly than target words that were embedded in sentences with a familiar intonation contour. Recall that the prosodic manipulation in Study 1 was in the prenuclear position. It was either on *morgens* ('in the morning') or on *Lola* in a sentence like *Gerne trinkt Lola morgens ein Glas Milch* ('Lola likes to drink a glass of milk in the morning'). Usually, the intonation contour falls towards the end of the sentence, so it is, in general, natural that a prenuclear accent might be phonetically stronger than a nuclear accent. However, in a sentence like *Gerne trinkt Lola morgens ein Glas Milch*, it is usually the first word that would get a prenuclear accent, thus *gerne* ('happily'). It is therefore possible that prosodically

prominent rises on *Lola* or *morgens* ('in the morning') were unfamiliar for the participants, thus slowing them down in the word-monitoring task.

Another decisive reason for not finding an effect of prosodic prominence on on-line language processing could be priming. Recall that in a word-monitoring task participants read the target word on the screen before the sentence is auditorily presented. This primes the target word for the following sentence, i.e., the target word is pre-activated. On the one hand, it might be possible that prosodic prominence could add on this priming effect. By drawing attention, a primed prosodically prominent target word could be identified even faster because it is not only pre-activated but the identification of the target word would also be facilitated by the prosodic prominence, as outlined in Chapter 3. On the other hand, a priming effect could override an effect of prosodic prominence. The target word has already been pre-activated and therefore the participants did not need to rely on the prosodic information of the word to identify it more easily. The results of Study 1 rather suggest that prosodic prominence might not play an additive role. Comparing the identification times of the target word when either the target word or the preceding word was prosodically prominent showed that there was no significant difference between identification times. This suggests that the priming effect might have overridden the effects of prosodic prominence on word identification.

Limitations and outlook

This section will discuss some of the limitations of Study 1 and will present an outlook to what future research could improve.

Picking up on the last point of the discussion, priming might have confounded the results of Study 1. In order to avoid a possibly confounding priming effect, alternative paradigms could be employed to test the effect of prosodic prominence on on-line language processing. For instance a lexical decision task could be conducted. In a lexical decision task, participants are presented with words and pseudowords and have to decide as quickly as possible if what they read or hear is a word or a nonce-word. The specific set-up could look like the following: Participants listen to words and pseudowords that are either recorded with an L+H* or are deaccented, ø. With this experimental set-up, the words would not be primed. If participants react faster when the word is presented with an L+H* compared to when it is deaccented, this could mean that it was a methodological issue why Study 1 did not find any effect of prosodic prominence on on-line language processing. In this case, the lexical decision task could be repeated testing more experimental conditions to find out if a graded effect of perceptual prominence would also lead to a graded effect of prosodic prominence on on-line language processing. If the lexical decision task also found no effect of prosodic prominence on reaction times, this would indicate that it was not a methodological issue but would rather indicate that prosodic prominence might not affect on-line language processing.

One might argue that testing different sentences across experimental conditions might have confounded the results. Other studies investigating the role of prosodic prominence on language processing used the same sentences across experimental conditions (e.g., Cutler & Swinney, 1987; Fraundorf et al., 2010; Kember et al., 2021). Note, however, that the word frequency, the duration in milliseconds, the number of phonemes, the type of adverbial, and the syllabic structure of the target words were

controlled for prior to the study. This allowed for testing unique sentences across experimental conditions. Additionally, testing different sentences across experimental conditions ensured a higher variability and naturalness, thereby enhancing the attention of the participants. Thus, testing unique sentences across experimental conditions is not necessarily a limitation but can be considered a strength of the study.

A related point is that although all stimuli were recorded in one session, the intonation within and between experimental conditions still naturally differed. This could not have been avoided as each experimental group had unique sentences. However, picking up on the point of the previous paragraph, if the same sentences were used in all experimental conditions, one carrier sentence could have been recorded and prosodically manipulated words could have been filled in by splicing. By doing this, all of the prosodic differences between experimental groups except for the manipulated word would be eliminated and would no longer possibly confound the results. However, other confounding effects could arise because splicing can disrupt the natural intonation of the sentence. Thus, splicing would rather relocate the problem but not solve it. Moreover, as mentioned in the previous paragraph, testing unique sentences across experimental conditions enhances the naturalness of the experiment and reflects reality. Furthermore, it is natural that the intonation of sentences differs although the intention, e.g., signalling contrast, is the same. That is, it resembles natural speech that the intonation of sentences within one experimental group was not identical.

6.2 Hindering effects of prosodic prominence on off-line language processing (RQ 2)

Based on previous studies that have repeatedly shown facilitatory effects of prosodic prominence on word recognition memory (Fraundorf et al., 2010; Kember et al., 2021; Zhou et al., 2024) and word recall (Savino et al., 2020; Röhr et al., 2022), the assumption that prosodic prominence draws attention, thereby occupying processing resources that are lacking for processing subsequent linguistic material, was put forward. This assumption is supported by Lialiou et al. (2024: 1117) who found that rising pitch accents "demand more attentional resources". Therefore, it is possible that prosodic prominence does not only facilitate language processing as shown for instance by Fraundorf et al. (2010) but that processing prosodic prominence might also be costly. To investigate if the processing of prosodic prominence is not only facilitatory in nature but also costly, a word recognition memory task was conducted where the word directly preceding the target word was prosodically manipulated with either an L+H* accent, that is high in perceived prominence, or the preceding word was deaccented (ø), i.e., it was low in perceived prominence. The results showed that the accuracy rate in the condition where the target word followed a highly prosodically prominent word was significantly lower than in the condition where it followed a word that was not prosodically prominent. These results confirm the assumption that prosodic prominence is not only facilitatory in nature but that processing prosodic prominence is also costly.

Previous studies have shown facilitatory effects of prosodic prominence on off-line language processing, more specifically word recognition memory (e.g., Fraundorf et al., 2010; Kember et al., 2021; Zhou et al., 2024). Zhou et al. (2024) for instance

attributed the recognition memory benefit of prosodically prominent words to a more enhanced semantic processing and, generally, argued for a prioritized processing of prosodically prominent words because participants deemed these words more important. As outlined in Chapter 3, prosodically prominent words might get processed in more depth by binding processing resources. Thus, the assumption that semantic processing is enhanced goes well together with the assumption that prosodic prominence binds processing resources. While the prosodically prominent word is prioritized and processed in more depth, the following word gets neglected and therefore remembered worse. The better recognition memory of prosodically prominent words and the worse recognition memory of words following prosodically prominent words therefore complement each other.

Lialiou et al. (2024) showed in their ERP-study with German speakers that intonational rises evoked a bigger mismatch negativity, which is an involuntary reaction to an auditory signal, than intonational falls. The authors concluded from this that rises orient more attention than falls. In German, rises are prosodically more prominent than falls (see Baumann & Röhr, 2015). Thus, the results by Lialiou et al. (2024) can also explain the result found in Study 2, that target words following prosodically prominent words were remembered worse than words that followed prosodically non-prominent words: Prosodic prominence orients attention, thereby binding processing resources. Cognitive resources are limited. It is thus likely that a word following a prosodically prominent word is worse processed because less processing resources are available. The results of Lialiou et al. (2024) and Study 2 therefore complement each other because they show the dual effect of prosodic

prominence: While prosodic prominence orients attention, it also occupies processing resources, thereby impairing the processing of the following word.

Most studies, such as Fraundorf et al. (2010), Kember et al. (2021) or Zhou et al. (2024) examined the effects of prosodic prominence on the target word. Koch & Spalek (2021), however, investigated whether prosodic prominence on one word would also affect the recall of surrounding words that belonged to the same taxonomic group. The first sentence introduced three entities from one taxonomic group, the third sentence re-mentioned one of the entities in either broad focus (H+!H*, prosodically less prominent) or in contrastive focus (L+H*, more prosodically prominent). Recall was tested by asking participants questions about the entities from the taxonomic group. The results showed a better recall for the two words accompanying the prosodically manipulated word when the re-mentioned word was manipulated with the prosodically more prominent accent type L+H* compared to the prosodically less prominent accent type H+!H*. At first sight, this seems to contradict the results of Study 2. Note, however, that Koch & Spalek (2021) tested if words that belonged to the same taxonomic group were recalled better when one of these entities was re-mentioned again with a contrastive focus, i.e., the words tested for recall were semantically related. Koch & Spalek (2021: 1326) argued that a deeper semantic processing was triggered by the contrastive focus from which especially the members of the contrast set benefitted. Therefore, the contrastive focus was meaningful. Study 2, however, tested the recognition memory of a completely unrelated word, namely the target adverbial that followed the prosodically prominent proper noun. In the sentence *Gerne trinkt Lola morgens ein Glas Milch* ('Lola likes to drink a glass of milk in the morning') the memory of *morgens* ('in the morning') was

tested when *Lola* was prosodically prominent. Thus, Study 2 tested the sheer effect of prosodic prominence on word recognition memory of the subsequent unrelated word, while Koch & Spalek (2021) used a slightly different methodology. Thus, while the accent type L+H* leads to a better recall of words that belong to one taxonomic group when one of the words is re-mentioned, the prosodically prominent L+H* also limits the ability to process words that immediately follow the prosodically prominent entity, when it is unrelated and not in a contrast to the prosodically prominent word, as shown in Study 2.

What is more, it is possible that the prenuclear L+H* accent on *Lola* in the sentence *Gerne trinkt Lola morgens ein Glas Milch* ('Lola likes to drink a glass of milk in the morning') was indeed so strong that it was interpreted as a nuclear accent because people might have perceptually inserted a boundary after *Lola* that was not intended in production. Boundaries help chunking and consequently this could have oriented more attention towards the prosodically prominent word, *Lola*, and bound more processing resources to it. Structurally speaking, nuclear accents are usually considered to be prosodically more prominent than prenuclear accents (see e.g., Baumann et al., 2015).

Limitations and outlook

This section will discuss limitations of Study 2 and will provide an outlook on what future research could improve.

Study 2 examined the effect of prosodic prominence on a target word that directly followed the prosodically prominent word. However, it is unclear whether the effect of prosodic prominence also spreads out to linguistic elements that are further

apart from the prosodically prominent entity. Future studies could manipulate the number of words between the prosodically manipulated word and the target word to investigate how long prosodic prominence impedes the processing of words that follow a prosodically prominent entity. This would allow to test how local the impeding effect of prosodic prominence on off-line language processing is.

Furthermore, Study 2 explicitly tested the influence of prosodic prominence on word recognition memory, where the highly prosodically prominent accent type L+H* was tested against the low prosodically prominent deaccentuation. While the condition deaccentuation, ø, served as the baseline condition in this experiment, it is, strictly speaking, still a marked form because it deviates from a natural intonation contour. Deaccentuation, ø, and L+H* were used because they are at the very ends of the scale of perceptual prominence by Baumann & Röhr (2015), and therefore most likely to yield a difference. Still, it might be interesting for future studies to test a prosodically prominent condition (L+H*) against a more natural condition where the nuclear accent still is on the last word of the sentence, but without a particular intonation on the word preceding the target word.

In Study 2, the experimental sentences were presented in isolation, without further context. For future studies, it can be interesting to investigate how a context sentence might influence the results. Let us assume that the experimental sentence *Gerne trinkt Lola morgens ein Glas Milch* ('Lola likes to drink a glass of milk in the morning') was preceded by a sentence where Lola does something in the evening, say *Abends isst Lola einen Salat* ('In the evening, Lola eats a salad'). This could lead to an overall improvement in the recognition memory of the target word *morgens* ('in the morning') because it is in contrast to *abends* ('in the evening'). Here, it might be

interesting to investigate both the effect of prosodic prominence when the target word is prosodically manipulated or when the preceding word is prosodically manipulated. An L+H*, which is both the prosodically most prominent accent type in German and prototypically signals contrastive focus, on the target word might lead to an enhanced memory thereof. This is based on the assumption that prosodically prominent accent types draw attention and furthermore because *morgens* ('in the morning') would be in contrast to *abends* ('in the evening'). This additive effect of prosodic prominence would not be expected when the word preceding the target word was prosodically prominent, leading to a worse recognition memory of the target word compared to when the target word itself was manipulated with an L+H*.

6.3 Why does prosodic prominence affect off-line and on-line language processing differently? (RQ3)

The initial research question was whether off-line and on-line language processing are affected differently by prosodic prominence. While no such difference was hypothesized, it was found that prosodic prominence impaired off-line language processing (Study 2) but did not affect on-line language processing (Study 1). This section therefore will discuss possible reason why prosodic prominence affected off-line but not on-line language processing.

One reason why prosodic prominence influenced off-line processing but not on-line processing could simply be due to the method that was used. Study 1 was a word-monitoring task where participants were instructed to listen for a particular target word, while Study 2 was a word recognition memory task where participants were not aware of the target word prior to sentence presentation. This might have

influenced the results. In the word-monitoring task (Study 1) participants might have concentrated on identifying previously defined target words, thereby weighing lexical information more important and prosodic information less important. Therefore it is possible that prosody played a minor role in this task because participants paid more attention to *what* was said compared to *how* it was said. In the word recognition memory task (Study 2) on the other hand, participants did not know the target word prior to sentence presentation. Rather, participants had to remember the whole sentence because they did not know for which word recognition memory was tested. It is therefore likely that participants weighed the prosodic information of the sentence more important in the word recognition memory task and thus paid more attention to the prosodic realisation of the sentence.

As outlined in Section 6.1, there is an on-going debate of the status of prenuclear accents. While some scholars argue for a pure ornamentality of prenuclear accents (e.g., Büring, 2007; Calhoun, 2010; Jagdfeld & Baumann, 2011; Kapatsinski, et al., 2017; Baumann et al., 2021), others assign functions to prenuclear accents (e.g., Féry & Krüger, 2008; Braun & Biezma, 2019; Roessig, 2023). Study 1 and Study 2 both tested the same experimental sentences with the prosodic manipulation in the prenuclear position. While Study 1 failed to find an effect of prosodic prominence on on-line language processing, Study 2 found an impeding effect of prosodic prominence on off-line language processing. Thus, it might be the case that it is not the prosodic manipulation in the prenuclear position per se that is responsible for the lack of an effect of prosodic prominence on on-line language processing in Study 1 but the interplay of the prosodic manipulation and the type of language processing that is tested. The integration of prosodic information may differ between on-line and off-

line language processing, irrespective of the accent position in the sentence (prenuclear or nuclear). For instance, Ladd (2008: 5) argued that "intonation conveys meanings that apply to phrases or utterances as a whole". In other words, prosody is "above" the word, thus it is important for the overall meaning and structure of a sentence rather than an individual word. The word-monitoring paradigm is designed to measure real-time processing, i.e., the immediate effect of prosodic prominence. It is therefore possible that the word-monitoring task did not measure the effect of prosodic prominence at all. Participants reacted to a target word that was in the middle of a sentence (recall that the target word *morgens* 'in the morning' was in the fourth position in a sentence like *Gerne trinkt Lola morgens ein Glas Milch* 'Lola likes to drink a glass of milk in the morning'). Thus, the participants reacted before the sentence was finished. It is possible that the prosodic information has not been fully processed when participants reacted. The word recognition memory task, on the other hand, tested the effect of prosodic prominence on off-line processing, i.e., after the sentence and its prosodic realisation was fully processed.

What do the results entail for the assumptions that prosodic prominence draws attention and binds processing resources?

Recall that it was postulated that prosodic prominence draws attention based on the results of Lialiou et al. (2024) who argued that prosodically prominent rises are special in orienting attention because they evoked the largest mismatch negativity. Further, prosodic prominence was argued to possibly facilitate the selection of words during auditory word recognition because prosodically prominent words are hyperarticulated (de Jong, 1995). This hyperarticulation renders words more

prominent and therefore possibly easier to differentiate from similarly sounding words. Thus, in a word-monitoring task, prosodically prominent words should be identified faster. Contrary to this expectation, prosodically prominent target words did not get identified faster when they bore a prosodically prominent accent type. This indicates that prosodically prominent accent types did not draw attention and selection was not facilitated. This further implies that selection might be robust and might not be influenced by prosodic cues. A lexical decision task could validate this claim. As outlined in Section 6.1 participants either read or hear words and pseudowords and have to decide as fast as possible if the word they read or hear is a word or not. In this case, participants would listen to words that either bear a prosodically prominent L+H* accent or are unaccented, thus prosodically less prominent. If participants reacted faster when the words were prosodically prominent compared to when they were not, the claim that lexical access might be robust and not be influenced by prosodic cues might be false. A non-significant difference of reaction times between prosodically more prominent and prosodically less prominent words could be counted as evidence favouring the claim that prosodic prominence might not influence lexical access.

Recall that it was further assumed that prosodic prominence might bind processing resources to the prosodically prominent word, enhancing its integration into memory (see e.g., Fraundorf et al., 2010; Kember et al., 2021; Zhou et al., 2024). Consequently, less processing resources are available for processing subsequent words. This could impede the processing of the word following a prosodically prominent word. Study 2 indeed found that a prosodically prominent accent type on the word preceding the target word led to a less accurate recognition memory of the target word

in a word recognition memory task. This suggests that prosodic prominence enhances the processing of the prominent word at the expense of the subsequent word. This implies that processing resources indeed might get bound by prosodic prominence orienting attention.

To summarize, the results do not show a clear picture of how prosodic prominence influences language processing in German. While the results imply that on-line processing is not affected by prosodic prominence, off-line processing was impaired by prosodic prominence. Future research is needed to further investigate how prosodic prominence is processed.

7. Conclusion

The goal of this dissertation was to examine the question how prosodic prominence influences language processing in German. In order to do so, a word-monitoring and a word recognition memory task were conducted, both measuring different levels of language processing, namely on-line and off-line processing, respectively. Prosodic prominence was hypothesized to draw attention, thereby leading to faster word identification in a word-monitoring task, when manipulated on the target word. Further, it was hypothesized that prosodic prominence is costly and binds processing resources, leading to slower identification times in a word-monitoring task when manipulated on the word preceding the target and, likewise, to a less accurate recognition memory of a target word that followed a prosodically prominent word in a word recognition memory task.

While the word-monitoring study (Study 1) did not show any effect of prosodic prominence at all on on-line language processing, the word recognition memory study (Study 2) found an effect of prosodic prominence on off-line language processing. This suggests that prosodic information is made use of differently depending on the task: It seems that prosodic prominence influences off-line language processing, as it impeded the recognition memory of a subsequent target word. On the other hand, it seems that prosodic prominence did not play a role in on-line language processing, as it neither facilitated nor hindered the identification of a target word.

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Supplementary material

Study 1a: Zeyer, Barbara & Penke, Martina. (2023). The processing of prosodic prominence in German. In Skarnitzl, Radek & Volín, Jan (eds.), *Proceedings of the 20th International Congress of Phonetic Sciences*, 4071–4075. Prague, Czech Republic: Guarant International.

Study 1b: Zeyer, Barbara & Penke, Martina. 2024b. Prosodic prominence does not speed up word recognition in a word monitoring task with German adult speakers. *Glossa: a journal of general linguistics* 9(1). doi: https://doi.org/10.16995/glossa.11244

Study 2: Zeyer, Barbara & Penke, Martina. 2024a. Prosodic prominence and its hindering effect on word recognition memory in German. *Proceedings of the 12th Speech Prosody*, 1135–1139. Leiden, Netherlands. doi: 10.21437/SpeechProsody.2024-229

Hinweis. Aus vertragsrechtlichen Gründen sind die Originalartikel in der vorliegenden Veröffentlichung nicht enthalten.

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Erklärung zu den Publikationen

Diese kumulative Dissertation umfasst drei Publikationen, die von mir als Erstautorin verfasst wurden: Zeyer & Penke (2023, 2024a, 2024b).

Die Datenerhebung, -aufbereitung, -analyse und -interpretation habe ich selbstständig durchgeführt.

Die Manuskripte für die Publikationen habe ich als Erstautorin selbstständig verfasst. Die Überarbeitung erfolgte in Rücksprache mit der Zweitautorin und Betreuerin Martina Penke. Dies gilt auch für die Revisionen der Manuskripte.

Barbara Zeyer

Eidesstattliche Erklärung

Ich, Barbara Zeyer, geboren am 04.06.1992, versichere eidesstattlich, dass ich die von mir vorgelegte Dissertation selbstständig und ohne unzulässige Hilfe angefertigt, die benutzten Quellen und Hilfsmittel vollständig angegeben und die Stellen der Arbeit einschließlich Tabellen, Karten und Abbildungen, die anderen Werken im Wortlaut oder dem Sinn nach entnommen sind, in jedem Einzelfall als Entlehnung kenntlich gemacht habe sowie dass diese Dissertation noch keinem anderen Fachbereich zur Prüfung vorgelegen hat. Die Promotionsordnung ist mir bekannt. Die von mir vorgelegte Dissertation ist von Martina Penke betreut worden.